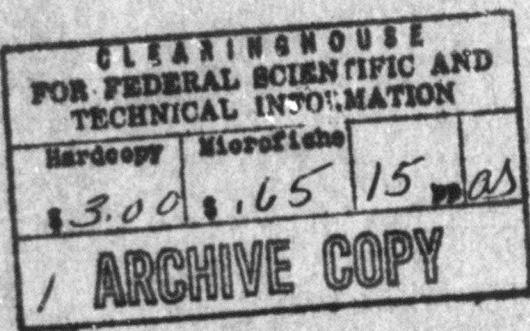


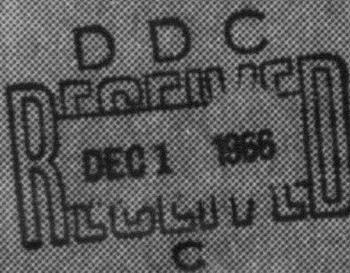
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TECHNICAL REPORT - 495-01-4.2

TRAINING 90 MM AA GUN CREWS
Appendix II - Statistical Analysis



SPECIAL DEVICES CENTER
PORT WASHINGTON, L.I., N.Y.



TECHNICAL REPORT - 495-01-4.2

TRAINING 90 MM AA GUN CREWS
Appendix II - Statistical Analysis

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SPECDEVCEN Project 20-H-1b
Contract Nonr-495(01)

This is a technical appendix to Human Engineering Report
SPECDEVCEN 495-01-4, Training 90 MM AA Gun Crews. It contains
the statistical data from which the tables in that report were
prepared.

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Distribution List

TABLE 2

	Test	M_{Diff}	T_{MD}	C.R.
Research - V 78.9 - 76.9	1	2.0	2.08	0.96
Research - U 71.0 - 67.8	2	3.2	1.62	1.98*
Research - V 71.0 - 69.2	2	1.8	2.07	0.87
Research - W 71.0 - 68.9	2	2.1	3.47	0.61
V - U 69.2 - 67.8	2	1.4	1.97	0.71
W - U 68.9 - 67.8	2	1.1	3.32	0.33
V - W 69.2 - 68.9	2	0.3	3.65	0.08
Research - V 82.3 - 60.9	3	21.4	3.29	6.50**
Research - W 82.3 - 65.6	3	16.7	3.82	4.37**
V - W 60.9 - 65.6	3	4.7	4.82	0.97
Research - X 78.9 - 75.0	4	3.9	1.61	2.42*
Research - Y 78.9 - 71.3	4	7.6	1.69	4.50**
X - Y 75.0 - 71.3	4	3.7	1.70	2.18*
Research - Z 80.3 - 56.4	Ind.	23.9	2.61	9.16**

* Significant at .05 level of confidence.

** Significant at .01 level of confidence.

In summary, all differences between the experimental and control batteries, favor the experimental. Of the nine differences, six are significant (2 at the .05 level and 4 at the .01 level).

2. Comparison of Different Methods of Instruction
(Refers to pp 15-18 in primary report)

Table 3

TABLE 3

	N	Σx	Σx^2	M	σ	σ_M	σ_{σ}
Test 1							
I	100	7181	562313	71.81	21.59	2.17	1.53
II	52	3856	306608	74.15	19.84	2.77	1.94
III	48	3300	245160	68.75	19.52	2.85	1.99
IV	188	14830	1223364	78.88	16.9	1.23	0.87
Test 2							
I	96	6500	475550	67.71	19.22	1.97	1.39
II	51	3626	272948	71.09	17.23	2.44	1.71
III	44	2655	170495	60.34	15.30	2.33	1.63
IV	172	12215	911921	71.02	16.1	1.23	0.87
Test 3							
I	95	7052	570712	74.23	22.29	2.30	1.62
II	51	3730	296852	73.14	21.70	3.07	2.15
III	44	3228	253856	73.36	19.68	3.00	2.10
IV	183	15061	1259981	82.30	10.6	0.78	0.55

Group I - Classroom instruction.

Group II - Gun park instruction.

Group III - No instruction.

Group IV - Combination of classroom and gun park instruction.

TABLE 4

Groups	Test	M_D	C.R.	Groups	Test	M_D	C.R.
IV - I	1	7.07	2.83**	IV - I	2	3.31	1.43
IV - II	1	4.73	1.56	IV - III	2	10.68	4.04**
IV - III	1	10.13	3.26**	I - III	2	7.37	2.42*
II - I	1	2.34	0.66	IV - I	3	8.07	3.32**
II - III	1	5.40	1.36	IV - II	3	9.16	2.89**
I - III	1	3.06	0.85	IV - III	3	8.94	2.88**
II - I	2	3.38	1.08	I - II	3	1.09	0.28
II - III	2	10.75	3.18**	I - III	3	0.87	0.28
II - IV	2	0.07	0.03	III - II	3	0.22	0.05

B. EMPLACEMENT AND MARCH ORDER

Table 5 Basic Data for Emplacement
 Table 6 Basic Data for March Order

1. Massed versus Spaced Practice
 (Refers to pp 21-22)

Table 7
 Table 8

2. Retention After Varying Amounts of Practice
 (Refers to pp 23-24)

Table 9
 Table 10

3. Comparison of Research Battery with Other Batteries
 (Refers to pp 26-27)

Table 11
 Table 12

TABLE 5

Group I

Trial	N	ΣX	ΣX^2	M	σ	σ_M
1	16	11004	8106612	687.7	183.0	47.25
2	15	7965	4431598	532.4	109.5	29.26
3	15	7231	3682261	482.0	114.5	30.60
4	15	6591	3096949	439.4	115.7	30.92
5	15	5909	2394887	393.9	66.9	17.89
6	15	5365	1965929	357.6	56.0	14.97
7	14	4983	1849689	355.9	73.7	20.44
8	9	3495	1415303	388.3	80.3	28.39
R1	14	8294	5367802	592.4	180.0	49.92
R2	12	5661	2702796	471.7	51.7	15.59
Group II						
1	16	11158	8441310	697.3	203.1	52.44
2	16	9800	6325866	612.5	142.2	36.71
3	16	8539	4752785	533.6	110.5	28.53
4	16	8180	4376480	511.2	110.2	28.45
5	16	7319	3444341	457.4	77.6	20.04
6	16	7126	3402732	445.3	119.6	30.88
7	16	7726	4097960	482.8	151.5	39.12
8	16	6933	3120591	433.3	85.3	22.02
R1	16	9992	6900598	624.5	203.2	52.46
R2	15	7193	3571221	479.5	90.1	24.08
Group III						
1	16	9918	6410734	619.8	128.1	33.07
2	16	9602	5942904	600.1	106.2	27.42
3	16	8264	4355896	516.5	73.9	19.08
4	10	4385	1955787	438.5	57.4	19.13
5						
6						
7						
8						
R1	16	9209	5432945	575.5	91.0	23.50
R2	16	7815	3947319	488.4	90.2	23.29

I = Massed 20 hrs.

II = Spaced 20 hrs.

III = Massed 10 hrs.

TABLE 6

Group I

Trial	N	Σx	Σx^2	M	σ	σ_M
1	16	17752	20508184	1109.5	225.3	58.2
2	16	12819	10565089	801.2	135.6	35.0
3	16	13301	11611283	831.3	186.1	48.1
4	16	11285	8276345	705.3	140.7	36.3
5	16	10483	6993229	655.2	88.4	22.8
6	15	9733	6552881	648.8	125.8	33.6
7	11	6031	3374395	548.3	78.5	26.2
8	7	4040	2367806	577.1	71.2	35.6
R1	14	10518	8242354	751.3	162.3	44.96
R2	12	7674	5252870	639.5	169.6	51.08
Group II						
1	16	17336	19953764	1083.5	270.4	69.8
2	16	13253	11394579	828.3	161.4	41.7
3	16	13532	12667342	845.7	276.4	71.4
4	16	11052	8076206	690.7	166.2	42.9
5	16	10551	7439351	659.4	173.5	44.8
6	16	10376	7023208	648.5	135.6	35.0
7	16	10769	7561361	673.0	139.9	36.1
8	15	10590	7801480	706.0	222.5	59.5
R1	16	13295	11960105	830.9	239.0	61.76
R2	10	8243	7754901	824.3	309.9	103.3
Group III						
1	16	14416	13500930	901.0	178.9	46.2
2	16	12849	10780347	803.0	169.9	43.9
3	15	10861	7847481	724.1	172.3	46.0
4	15	10261	7168135	684.0	191.6	51.2
5						
6						
7						
8						
R1	16	12901	10849505	806.3	167.2	43.20
R2	15	10890	8191788	726.0	138.0	36.90

I = Massed 20 hrs.

II = Spaced 20 hrs.

III = Massed 10 hrs.

TABLE 7. EMPLACEMENT: MASSED VS SPACED PRACTICE

Group	Trial	M_{Diff}	σ_{MD}	C.R.
I - II 482.0 - 533.6	3	51.6	41.83	1.23
I - III 482.0 - 516.5	3	34.5	36.15	0.95
II - III 533.6 - 516.5	3	17.1	34.33	0.50
I - II 439.4 - 511.2	4	71.8	42.01	1.71
I - III 439.4 - 438.5	4	0.9	36.36	0.02
II - III 511.2 - 438.5	4	72.7	34.28	2.12*
I - II 355.9 - 482.8	7	126.9	44.14	2.87*
I - II 388.3 - 433.3	8	45.0	35.82	1.26

* Significant at .05 level.

Summary: Massed practice is superior; ten hours of instruction is adequate.

Group I - Massed Practice - 20 hours of instruction

Group II - Spaced Practice - 20 hours of instruction

Group III - Massed Practice - 10 hours on instruction

TABLE 8. MARCH ORDER

	Trial	M _{Diff}	\bar{G}_{MD}	C.R.
1st cycle - 2nd cycle 831.3 - 845.7	3	14.4	86.09	0.17
1st cycle - 3rd cycle 831.3 - 724.1	3	107.2	66.56	1.61
2nd cycle - 3rd cycle 845.7 - 724.1	3	121.6	86.1	1.41
1st cycle - 2nd cycle 705.3 - 690.7	4	14.6	56.20	0.26
1st cycle - 3rd cycle 705.3 - 684.0	4	21.3	62.76	0.34
2nd cycle - 3rd cycle 690.7 - 684.0	4	6.7	66.80	0.10
1st cycle - 2nd cycle 548.3 - 673.0	7	124.7	44.60	2.80*
1st cycle - 2nd cycle 577.1 - 706.0	8	128.9	69.33	1.86

* Significant at .05 level.

TABLE 9

Group	Trial	M _{Diff}	\bar{V}_{MD}	C.R.
II - I 624.5 - 592.4	1	32.1	72.4	0.44
II - III 624.5 - 575.5	1	49.0	57.5	0.85
I - III 592.4 - 575.5	1	16.9	55.2	0.31
II - I 479.5 - 471.7	2	7.8	28.7	0.27
II - III 479.5 - 488.4	2	8.9	33.5	0.27
I - III 471.7 - 488.4	2	16.7	28.0	0.60

Summary: There are no significant differences in retention for groups receiving ten and twenty hours of instruction.

TABLE 10

Group	Trial	M _{Diff}	\bar{V}_{MD}	C.R.
II - I 830.9 - 751.3	1	79.6	76.4	1.04
II - III 830.9 - 806.3	1	24.6	75.4	0.33
I - III 751.3 - 806.3	1	55.0	62.4	0.88
II - I 824.3 - 639.5	2	184.8	115.3	1.60
II - III 924.3 - 726.0	2	98.3	109.7	0.90
I - III 639.5 - 726.0	2	86.5	63.0	1.37

Summary: No significant differences.

TABLE 11

Battery	Emplacement time scores					
	N	$\sum X$	$\sum X^2$	M	t	t_M
Research	15	5909	2394887	393.93	66.90	17.90
X	8	7152	6511174	894.00	121.08	45.69
Y	16	17369	19386117	1085.56	182.18	47.07
Emplacement error scores						
Research	15	49	223	3.27	2.05	0.55
X	8	118	1799	14.75	2.70	1.02
Y	16	256	4262	16.00	3.22	0.83
Emplacement time scores						
Battery	M_{Diff}	t_M	C.R.			
Research - X 393.93 - 894.00	500.07	49.1				10.18**
Research - Y 393.93 - 1085.56	691.63	50.4				13.72**
X - Y 894.00 - 1085.56	191.56	65.6				2.92**
Emplacement error scores						
Research - X 3.27 - 14.75	11.48	1.16				9.90**
Research - Y 3.27 - 16.00	12.73	0.99				12.81**
X - Y 14.75 - 16.00	1.25	1.32				0.95

** Significant at .01 level.

Summary: Experimental procedures are supported.

TABLE 12

Battery	March order time scores					
	N	ΣX	ΣX^2	M	σ	σ_M
Research	16	10382	6974082	648.88	121.84	31.48
X	8	8009	8174817	1001.12	140.00	52.83
Y	16	24358	38244534	1522.38	269.53	69.65
March order error scores						
Research	16	84	590	5.25	3.05	0.79
X	8	130	2163	16.25	2.51	0.95
Y	16	368	9814	23.00	9.19	2.37
March order time scores						
Battery	M_{Diff}		σ_M		C.R.	
Research - X 648.88 - 1001.12	352.24		61.50		5.73*	
Research - Y 648.88 - 1522.38	873.50		76.40		11.43*	
X - Y 1001.12 - 1522.38	521.26		87.40		5.96*	
March order error scores						
Research - X 5.25 - 16.25	11.00		1.24		8.87*	
Research - Y 5.25 - 23.00	17.75		2.50		7.10*	
X - Y 16.25 - 23.00	6.75		2.55		2.65*	

* Significant at .01 level.

Summary: Experimental group makes significantly fewer errors than control groups.

C. ORIENTATION AND SYNCHRONIZATION

1. Comparison of Various Programs
 (Refers to pp 28-30)
 Table 13
 Table 14

TABLE 13

Program	Trial	N	$\sum X$	$\sum X^2$	M	σ	σ_M
II	1	16	627	24939	39.19	4.80	1.24
III	1	16	600	23052	37.50	5.87	1.52
II	2	12	411	14568	34.25	6.40	1.93
III	2	16	488	15915	30.50	8.03	2.07
II	3	12	431	15668	35.92	3.96	1.19
III	3	14	406	12498	29.00	7.19	1.99
II	4	12	483	20677	40.25	10.01	3.02
III	4	16	445	13241	27.81	7.35	1.90
II	5	10	411	17503	41.10	7.82	2.61
III	5	16	374	8976	23.38	3.82	0.99
II	6			No trial 6 for this group.			
III	6	16	316	6491	19.75	1.25	0.32

TABLE 14. CRITICAL RATIOS OF MEAN DIFFERENCES

Group	Trials				
	1	2	3	4	5
III - II	0.86	1.32	2.98*	3.57**	4.32**

Significant differences are present from the 3rd trial.

D. PREVENTIVE MAINTENANCE

1. Comparison of Research With Other Batteries
(Refers to p 34)

TABLE 15. COMPARISON OF SCORES ON INDIVIDUAL TEST
(Score is number right.)

Group	N	ΣX	ΣX^2	M	t	t_M
Research	48	2563	141503	53.39	9.84	1.43
Battery X	29	1108	45276	38.21	10.07	1.90
Battery Y	29	994	38494	34.28	12.34	2.33

TABLE 16. SIGNIFICANCE OF DIFFERENCE BETWEEN MEANS

Group	C.R.
Research - X	6.38*
Research - Y	7.00*
X - Y	1.31

* Significant at .01 level.

E. RADAR TRACKING PERFORMANCE

TABLE 17. TRACKING DATA: HIGH AND LOW AGCT GROUPS
(Time in seconds)

Group	Trials	N	ΣX	ΣX^2	M	t	$t^* M$
High	1-10	40	1252	48500	31.3	15.25	2.44
Low	1-10	30	1510	97752	50.3	26.9	4.99
High	11-20	39	924	28808	23.7	13.31	2.16
Low	11-20	30	1068	43816	35.60	13.9	2.58
High	21-30	39	839	26373	21.5	14.59	2.37
Low	21-30	30	848	28156	28.27	11.8	2.19
High	31-40	40	673	13235	16.8	6.90	1.10
Low	31-40	30	822	25442	27.40	9.9	1.84
High	41-50	37	662	14626	17.9	8.65	1.44
Low	41-50	30	864	28422	28.8	10.9	2.02

TABLE 18. CRITICAL RATIOS OF MEAN DIFFERENCES

Group	Trials				
	1-10	11-20	21-30	31-40	41-50
Low-High	3.43**	3.54**	2.16*	4.95**	4.41**

* .05 level.

** .01 level.